# The Distribution of the New Holland Mouse *Pseudomys novaehollandiae* (Waterhouse 1843) in the Eastern Otways, Victoria.

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**Abstract**

The results of trapping studies carried out in the Eastern Otways, Victoria between 1981 and 1992 were analysed to determine the distribution of *Pseudomys novaehollandiae*. The species has a patchy distribution and was captured at only ten of the 96 sites trapped. The sites where *P. novaehollandiae* was captured were located on flat to undulating terrain, on soils derived from Tertiary sediments. The species occurred in woodland and low-open forest with heathy understorey and preferred early successional vegetation. An area of approximately 2,300 hectares, located east of the Anglesea River, represents critical habitat for the species. Six of the sites where *P. novaehollandiae* was recorded occur in the Alcoa Lease area, and four in the Flora and Fauna Reserve. A number of processes that represent threats to the survival of this species in the area were identified. They included potential land clearance, recreational pressures and inappropriate fire regimes.

**Introduction**

The New Holland Mouse (*Pseudomys novaehollandiae*) has been recorded at mainly coastal locations in New South Wales, Victoria and Tasmania (Mahoney and Marlow 1968; Keith and Calaby 1968; Posamentier and Recher 1974; Seebeck and Beste 1970; Hocking 1980). It occurs in heathland and woodland (Posamentier and Recher 1974; Braithwaite and Gullan 1978; Kemper 1977; Hocking 1980), dry sclerophyll forest with dense shrub layer (Keith and Calaby 1968; Seebeck and Beste 1970; Fox and McKay 1981) and on vegetated sand dunes (Keith and Calaby 1968). Posamentier and Recher (1974) proposed that the optimum habitat for the species was heath, actively regenerating after fire. The studies of Fox and McKay (1981) and Fox (1982) showed that *P. novaehollandiae* populations survived wildfire and reached maximum abundance at 2-3 years after the fire. Studies of the species in coastal heath and open-forest regenerating after sand mining showed that the abundance of the species increased with regeneration age (Fox and Fox 1978, 1984; Twigg *et al.* 1989).

*Pseudomys novaehollandiae* was first recorded in Victoria near Tyabb on the Mornington Peninsula (Seebeck and Beste 1970). It has since been found at a number of sites on the coastal plains including Cranbourne (Braithwaite and Gullan 1978), Langwarrin, Wilson's Promontory and several sites in Gippsland (Norris *et al.* 1979; Department of Conservation and Environment, Wildlife Management Branch, *unpubl. data*). The species has a restricted, disjunct distribution in Victoria, and west of Melbourne has only been found at Anglesea in the Eastern Otway Ranges (Kentish 1982). It is considered to be an endangered species lacking adequate protection (Ahern 1982; Ahern *et al.* 1985; Menkhorst *et al.* 1987) and has recently been listed under the Victorian Flora and Fauna Guarantee Act (1988). Information on the ecology of *P. novaehollandiae* in Victoria is limited. Two studies of the species at Cranbourne (Braithwaite and Gullan 1978) and Langwarrin (Opie 1983) found that *P. novaehollandiae* preferred immature dry heath regenerating after clearing and fire (2-8 years postfire age). In the Eastern Otways two populations were studied between 1985 and 1989, after the 1983 Ash Wednesday wildfire (Wilson *et al.* 1990; Wilson 1991). The population density was low (0-3.1 $ha^{-1}$). Breeding occurred

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from spring to summer. The species exhibited micro-habitat preferences for vegetation of high floristic diversity and within these floristic groups a preference for low, dense vegetation cover (Wilson *et al.* 1990; Wilson 1991). Both of the populations studied in the Eastern Otways declined to extinction in 1989.

The results of a number of small mammal trapping studies carried out in the Eastern Otways are examined in this paper in order to determine the distribution of the species in the area, and to investigate factors that may be important for predicting its distribution.

## The study area

The study area in the Eastern Otways (Fig. 1) occurs on a dissected plateau and consists of mainly Tertiary sediments overlying older Cretaceous strata. Pitt (1981) identified four mainland systems based on climate, geology, topography, soil and vegetation: Anglesea; Bald Hills; Gherang Gherang and Mogg's Creek. The soils in the area (e.g. sandy podzols, lateritic podzolic) are of low fertility (Walbran 1971). The vegetation communities consist of a diverse mosaic of mainly sclerophyllous forests, woodlands and heathlands (Land Conservation Council 1985; Meredith 1986; Wark *et al.* 1987).

The area is predominantly public land with a major proportion consisting of the Alcoa Lease area (7,350 ha). Other areas include the Angahook State Park, Flora Reserves, Coastal Reserve and private land such as that previously known as the International Harvester testing grounds. In 1992 approximately 7,500 ha was listed on the Register of the National Estate because of its botanical and faunal values. The 'Ash Wednesday' wildfires in 1983 severely burnt approximately 40,000 ha of the Otway Ranges, including the study area. Several studies of post-fire revegetation and small mammal recolonisation were initiated, and are reported elsewhere (Wilson and Moloney 1985; Wark *et al.*

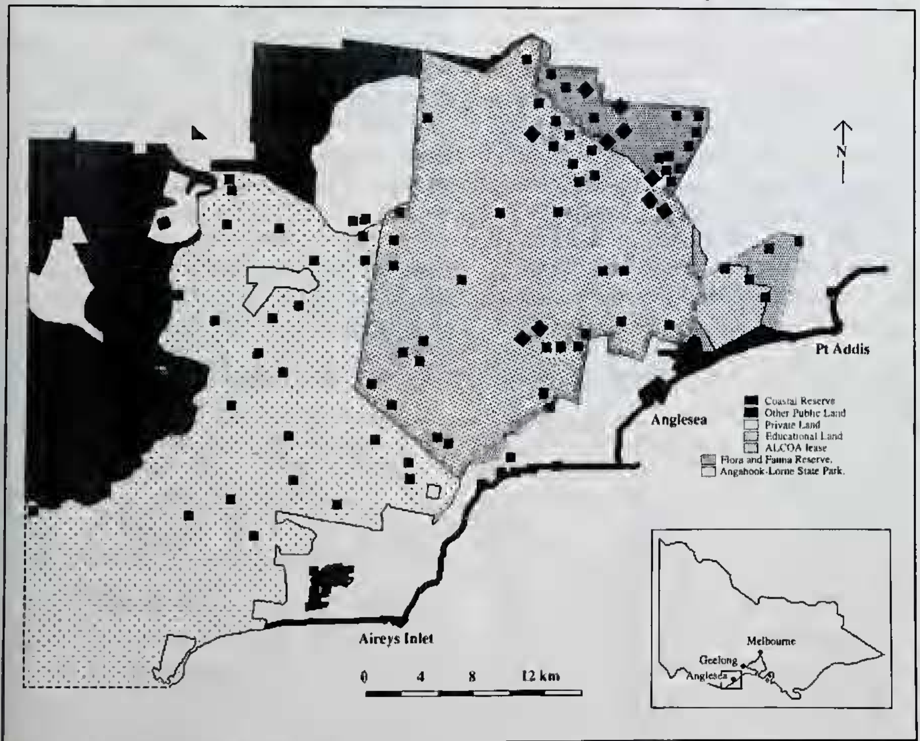


**Fig. 1.** The study area in the Eastern Otways.

**Table 1.** Small mammal trapping surveys in the Eastern Otways (1981-1992) (*7 sites in common).

| Years | Number of sites | Study |
|---|---|---|
| 1980-82 | 10 | Kentish (1982) |
| 1983-92 | *33 | Wilson *et al.* 1990, Aberton unpubl. |
| 1986-87 | 17 | Wilson (1991) |
| 1987 | *22 | Laidlaw and Wilson (1988) |
| 1990-91 | 14 | Wilson, McLeod and Mills unpubl. |
| 1991 | 7 | Wilson, Belcher and Nichols unpubl. |

1987; Wilson *et al.* 1990).

## Methods

A number of trapping studies have been carried out in the study area between 1981 and 1992 (Table 1). A total of 96 sites were trapped in a range of vegetation types and the data from these studies have been collated and examined. Live trapping and capture-mark-release techniques were similar to those described previously (Wilson *et al.* 1986, 1990). The trapping intensity ranged from 30-50 traps, set over a period of three to five nights. The identification number of the animal, its site of capture, weight and routine body measurements were recorded. The physical factors and vegetation at sites where *P. novaehollandiae* was captured were described. Topographic, geological and soil information was collated from maps, and observations were made on the sites. The recorded attributes of vegetation structure included the number of strata and their heights, and the percentage of projective foliage cover of the tallest strata. This data was used to describe the structural vegetation types (Specht 1981). The dominant species in the upper-, mid- and understorey were recorded. The age of the vegetation since fire was determined from maps and knowledge of the author. The land tenure of the sites was described and threatening factors or processes for the species were assessed.

## Results

*Pseudomys novaehollandiae* was captured at only ten sites (Fig. 1), and trapping success rates were low (0.5-5.5 per 100 trap nights). The species is currently (1993) present at only four of these ten sites (Table 2). The populations at Coalmine Road were last recorded in 1982 and were eliminated by the Ash Wednesday fire in 1983. No populations have been recorded west of the Anglesea River since 1982. All other populations have been recorded within an area of approximately 2,300 ha east of the Anglesea River. Survey trapping nearby to sites where *P. novaehollandiae* was recorded normally resulted in no captures, indicating that the populations are very localised. Five native and two introduced small mammal species were captured on sites with *P. novaehollandiae* (Table 2).

The sites where *P. novaehollandiae* was captured were located from 2 to 7 km inland on flat to undulating sites at altitudes from 50 to 100 m above sea level.

**Table 2.** Number of individual *P. novaehollandiae* captured (* sites where *P. novaehollandiae* is present-1992).

| Site | Date | Trap nights | Nos. of individuals | **Other species captured |
|---|---|---|---|---|
| Coalmine Rd. (1) | May 81 | 200 | 2 | Sle, Rlu, Am, Mm |
| Coalmine Rd.(2) | July 81 | 200 | 1 | Sle, Am, Rlu |
| Forest Rd. (5) | Apr. 85 | 90 | 3 | Mm |
| Pipeline Tk.(8) | Apr. 86 | 90 | 1 | Ast, Mm |
| Pipeline Tk.(9) | May 86 | 80 | 3 | Ast, Rlu, Rfu, Mm |
| Forest Rd. (7) | Sep. 86 | 80 | 1 | Mm |
| *Harrisons Tk.(9) | Jan. 91 | 90 | 5 | - |
| *Flora Res. (2) | Apr. 91 | 90 | 2 | Mm, Rn |
| *Flora Res. (3) | Apr. 91 | 90 | 3 | Mm |
| *Flora Res. (8) | June 91 | 90 | 4 | Ast, Mm |

** Species. *Ast (Antechinus stuartii), Am (Antechinus minimus), Sle (Sminthopsis leucopus), Rlu (Rattus*

The sites occur in two of the major land systems, Bald Hills and Gherang Gherang. The species was not recorded on the Anglesea or Mogg's Creek land systems. The sites are on soils derived from Tertiary sediments; in the Bald Hills these sediments are known as the eastern View Formation (Paleocene) and in Gherang Gherang the Demons Bluff (Eocene) formation (Pitt 1981). The soils in the Bald Hills system are of quartz, sand, gravel and clay parent material and include grey sand, yellow gradational and grey gradational soils. In Gherang Gherang the parent material is quartz gravel sand, siliceous sands, laterized sediments. The soils are mottled yellow and grey duplex with ironstone, stony yellow gradational and lateritic podzolics (remnants of younger plateau).

The vegetation where *P. novaehollandiae* was recorded was low woodland to low open-forests with heathy understoreys (Table 3). The species was captured in an old pine plantation, however, the site was adjacent to (<100 m) native vegetation and animals may not have been residents. The predominant species in low woodland and low-open forest included *Eucalyptus obliqua, Eucalyptus willisii, Leptospermum continentale, Leptospermum myrsinoides, Epacris impressa, Acacia myrtifolia, Banksia marginata, Gahnia radula.* At some sites there were small areas of scrub dominated by *L. continentale* associated with wet, damp depressions. The species was not recorded in open forests, scrub (sand dunes), fern gullies or *Melaleuca* swamps.

The age of the vegetation when *P. novaehollandiae* has been recorded ranges from 3 to 20 years (Table 3). The known fire history of the sites included fuel reduction burning and the major wildfire of 1983.

Six of the ten sites where *P. novaehollandiae* was recorded occur on the Alcoa Lease area and four were in the Flora and Fauna Reserve (Table 4). The Alcoa Lease covers an area of 7,350 ha (Fig. 1). It has been leased to Alcoa Australia Pty Ltd since 1961 for brown coal mining.

A range of possible threatening processes has been identified. Current proposals to clear land in the area for use in sewerage treatment could contribute to fragmentation of present populations. Inappropriate fuel reduction burning could threaten the survival of populations. Although the species prefers early stage successional vegetation, burning of extensive areas could eliminate populations and further fragment them. Recreation such as horse riding and trail bike riding occur within the habitat of the species. Resultant trampling and erosion causes damage to the vegetation. The presence of the Cinnamon Fungus (*Phytophthora cinnamomi*) has been recorded in the area. This plant pathogen devastates some vegetation communities and thus disturbs the habitat of animals. *P. novaehollandiae* populations may also be susceptible to predation by cats, dogs and foxes. The impact of predators on the species is unknown.

**Discussion**

The results of trapping studies over a ten year period show that *P. novaehollandiae* has a patchy distribution in the Eastern Otways. The present known distribution is restricted to an area of approximately 2,300 ha east of the Anglesea River. Prior to 1983 the distribution extended to the west of the river and covered an area of 3,000 ha. The populations recorded west of the river in 1981 (Kentish 1982) were eliminated by the wildfire in 1983. It is likely that the presence of the open-cut coal mine, begun in the late 1950s, contributed to fragmentation of the populations, and that the extensive 1983 wildfire was a stochastic disaster which led to the demise of this part of the distribution. The sites where the species has been located are flat to undulating, between 50 m and 100 m above sea level. They are restricted to two major land systems, Bald Hills and Gherang Gherang on soils derived from Tertiary sediments. The patchy nature of the distribution could be related to local soil variability. *Pseudomys novaehollandiae* inhabits burrows and Fox and Fox (1978, 1984) have shown that softer substrates and top-soil depth are important variables correlated with the biomass of the species.

The vegetation at sites where the species was recorded, consisted of low woodland to low open-forest with heathy understorey. In Victoria the species has been recorded in heathland, woodland and open-forest with heath understorey (Seebeck and Beste 1970; Braithwaite and Gullan 1978; Norris *et al.*1983; Opie 1983). It has also been recorded on primary sand dunes in sedgefield with a coastal shrub layer (Menkhorst 1990 *unpubl. data*). Analyses of the microhabitat use of *P. novaehollandiae* in the Eastern Otways have shown that it prefers two floristically rich vegetation groups (Wilson 1991). One group was dominated by understorey species such as *Epacris impressa, Hibbertia stricta, Acacia myrtifolia, Banksia marginata* and *Leptospermum continentale*. The dominant species in the second group were *Dillwynia glaberrima, Hypolaena fastigiata, Amperea xiphoclada and Empodisma minus.* Although structural factors were not important to overall preference, they did contribute to within group preference where the volume of the vegetation in the lower understorey was important (Wilson 1991). Thus floristic and structural requirements affect the patchy distribution.

The age of the vegetation where *P. novaehollandiae* was captured ranged from 3 to 20 years, most sites being of early successional age (3-4 years). The animals located at the 20 year old site were trapped in a patch of *L. continentale* left unburnt during the 1983 wildfire. Subsequently they moved out of this patch into the surrounding regenerating vegetation (Wilson 1991). Thus the species may survive in old patches, but probably only at very low densities. It is not clear what features of the early successional stage are important. A high floristic diversity may provide a variety of plants to produce seeds for this predominantly granivorous species (Watts and Braithwaite 1978; Cockburn 1980). Another factor worthy of investigation is the productivity of the vegetation. Early successional vegetation may have greater seed production compared to ageing vegetation. The importance of these changes are presently being determined.

The physical and biological data obtained can now be analysed more intensively. The aim will be to produce a predictive model which provides a better definition of the major factors determining the presence and abundance of *P. novaehollandiae* in the area. This can then be used to determine potential habitat more accurately. This data would be valuable to locate further populations and identify potential habitat into which animals may migrate.

The patchy distribution of the species indicates that populations may be spatially associated in a metapopulation. There is a need to determine how a metapopulation structure may contribute to the viability of the species in the Eastern Otways. Preliminary work has been carried out on a population viability analysis (PVA) which may assist in answering such problems (Wilson and Myroniuk 1992). There is evidence that the species has become extinct in recent times (20 years) in reserves east of Melbourne e.g. Tyabb, and Langwarrin reserves (Wilson 1992, 1993). These reserves are small in area (20 and 214 ha respectively) indicating that area may have been a contributing factor to the demise of the species. Attention should be focussed on the populations in the Eastern Otways, where the area of potential habitat is much greater. Isolated populations should be joined so they can act as a metapopulation, and migration and gene flow are enhanced.

Since six of the sites where *P. novaehollandiae* was recorded are located in the Alcoa Lease and four in the adjacent Flora Reserve (Fig. 1), the total area comprising 2,300 ha at present represents critical habitat for *P. novaehollandiae*. It should be managed with care and threatening processes should be addressed. Land

**Table 3.** General description of sites where *P. novaehollandiae* was captured. The numbers under the locations refer to trapping sites.

| Location, Altitude | Topography, Geology, Soils | Vegetation structure (Specht 1981) Dominant species | Fire history Age |
|---|---|---|---|
| Coalmine Rd (1)s9 2km inland 75m | Hillside, well drained. Soils derived from Demon's Bluff, Eastern View formations. Sandy, loam | Low woodland *E. baxteri, E. radiata* (7m), *L. continentale, L. myrsinoides, A. myrtifolia, A. suaveolens, B. marginata, P. obtusangulum* | wildfire 1969 13 years |
| Coalmine Rd (1)s8 2km inland 50m | Lower hillside, depression Soils derived from Demon's Bluff, Eastern View formations. Sandy, loam | Low woodland, scrub *E. radiata* (7m), *L. continentale, L. myrsinoides, E. impressa, A. suaveolens, B. marginata,* | wildfire 1969 13 years |
| Forest Rd (05) 5 km inland 100m | Flat to undulating. Soils derived from Demon's Bluff formation. Sandy gravel, loam,clayey quartz | Low open-forest, scrub *E. obliqua, E. willisii* (7-11m), *E. impressa, A. pycnantha, A. myrtifolia, L. continentale, L. myrsinoides, G. radula Lepidosperma semiteres* | old patch 20 years |
| Forest Rd (1b) 5 km inland 100m | Flat. Soils derived from Demon's Bluff. Sandy gravel,loam, clayey quartz | Low open-forest *E. obliqua, E. willisii* (13m), *L. continentale, L. myrsinoides, Poa spp. P. obtusangulum, A. myrtifolia, G. radula* | wildfire 1983 4 years |
| Pipeline Tk (1) 4km inland 70 m | Undulating. Soils derived from Demon's Bluff, Eastern View Clayey silt to fine sand | Woodland, scrub *E. obliqua, E. willisii* (7m), *X. australis, P. esculentum, G. radula, L. continentale, L. myrsinoides, L. semiteres, E. impressa, B. marginata, D. glaberrima* | wildfire 1983 4 years |
| Pipeline Tk (2) 4km inland 70 m | Undulating Soils derived from Demon's Bluff, Eastern View Clayey silt to fine sand | Woodland, scrub *E. obliqua, E. willisii* (7m), *X. australis, P. esculentum, G. radula, L. continentale, L. myrsinoides, L. semiteres, E. impressa, B. marginata, D. glaberrima* | wildfire 1983 4 years |
| Harrisons Tk. 6km inland 50m | Hillside Loamy coarse sand | Low woodland, scrub *E. obliqua, E. willisii* (7m), *L. myrsinoides, E impressa, H. fastigiata, D. sericea* | wildfire 1983 9 years |
| Flora Res 2 6 km inland 100m | Flat. Soils from Demon's Bluff. Loamy, sand. | Old pine plantation *P. radiata, A. myrtifolia, A. serrulata, G. radula, H. stricta, P. obtusangulum.* | wildfire 1983 frb 1989 3-4 years |
| Flora Res 3 6 km inland 100m | Flat. Soils from Demon's Bluff. Loamy, sand. | Low open-forest *E. obliqua, A. myrtifolia, A. serrulata, B. marginata, G. ecostatum, L. virgatus* | wildfire 1983 frb 1989 3-4 years |
| Flora Res 8 6 km inland 90m | Flat. Soils from Demon's Bluff. Loamy, sand. | Low open-forest *E. obliqua, A. myrtifolia, A. serrulata, B. marginata, G. ecostatum, L. virgatus* | wildfire 1983 frb 1989 3-4 years |

clearance and recreation such as trail bike and horse riding which modify and fragment habitats further should be eliminated. The distribution of *P. cinnamomi* should be determined because it has been found to affect the density and diversity of small mammals (Wilson *et al.* 1990; Newell and Wilson 1993), but the

**Table 4.** Land tenure of trapping sites and localities of *P. novaehollandiae*.

| | Land Tenure Units | | | | | |
|---|---|---|---|---|---|---|
| | Alcoa Lease | Angahook State Park | Coastal Reserve | Flora Reserve | International Harvester | Roadside Reserve |
| Total number of sites | 45 | 22 | 6 | 11 | 2 | 10 |
| Number of sites for *P. novaehollandiae* | 6 | 0 | 0 | 4 | 0 | 0 |

effect on *P. novaehollandiae* and its habitat, however, has not been determined. The effect of introduced predators such as foxes, cats and dogs should also be investigated.

Fire regimes need careful investigation and design, as large extensive fires could wipe out the fragmented populations. Judicious use of small patch burning may be the only way to create suitable patches of preferred early successional habitat and increase its area. An understanding of the spatial structure of populations is required to enable the appropriate patch sizes and distances between them to be determined.

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